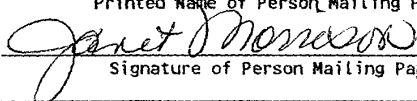
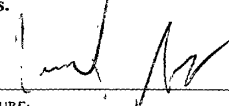


JCS8 Rec'd PCT/PTO 31 JAN 2001

FORM PTO-1390 (REV 10-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 33220	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/762073	
INTERNATIONAL APPLICATION NO. PCT/JP00/03568		INTERNATIONAL FILING DATE 01 June 2000 (01.06.00)		PRIORITY DATE CLAIMED 03 June 1999 (03.06.99)	
TITLE OF INVENTION RADIO COMMUNICATIONS APPARATUS, METHOD FOR CONTROLLING TRANS- MISSION POWER OF RADIO COMMUNICATIONS APPARATUS AND RECORDING MEDIUM TO WHICH APPLICANT(S) FOR DO/EO/US THE METHOD BEING RECORDED ICHIKAWA, Yasufumi					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)). 4. <input type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (PCT Article 31). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).					
Items 11 to 16 below concern document(s) or information included:					
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. with 8 references					
12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.					
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.					
14. <input type="checkbox"/> A substitute specification.					
15. <input type="checkbox"/> A change of power of attorney and/or address letter.					
16. <input checked="" type="checkbox"/> Other items or information: "Express Mail" mailing label number <u>EL595431903US</u> International Search Report Date of Deposit <u>1/31/2001</u> Check for \$1224.00					
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.					
Janet Morrison Printed Name of Person Mailing Paper or Fee					
 Signature of Person Mailing Paper or Fee					

U.S. APPLICATION NO. (if known, use 37 CFR 1.53) 09/762073		INTERNATIONAL APPLICATION NO. PCT/JP00/03568		ATTORNEY'S DOCKET NUMBER 33220	
17. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO. \$860.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	23 - 20 =	3	X \$18.00	\$	54.00
Independent claims	2 - 3 =	0	X \$80.00	\$	-----
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$270.00	\$	270.00
TOTAL OF ABOVE CALCULATIONS =				\$	1,184.00
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$	
SUBTOTAL =				\$	1,184.00
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	-----
TOTAL NATIONAL FEE =				\$	1,184.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	40.00
TOTAL FEES ENCLOSED =				\$	1,224.00
				Amount to be refunded:	\$
				charged:	\$
a. <input checked="" type="checkbox"/> A check in the amount of <u>\$ 1,224.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$_____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>16-0820</u> . A duplicate copy of this sheet is enclosed. <div style="text-align: center;">Order No. 33220</div>					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO Michael W. Garvey Pearne & Gordon LLP 526 Superior Ave. East Suite 1200 Cleveland, Ohio 44114-1484					
				SIGNATURE:  Michael W. Garvey NAME 35878 REGISTRATION NUMBER	

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Yasufumi Ichikawa
Serial No.: N/A
Filed: Herewith
Title: RADIO COMMUNICATIONS APPARATUS, METHOD FOR
CONTROLLING TRANSMISSION POWER OF RADIO
COMMUNICATIONS APPARATUS AND RECORDING MEDIUM
TO WHICH THE METHOD BEING RECORDED
Docket No.: 33220

PRELIMINARY AMENDMENT "A"

BOX PCT
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir/Madam:

Please amend the above-identified application, prior
to examination thereof, in the following manner.

IN THE DRAWINGS:

Delete "Drawing Sheet 1/4", and insert attached --Drawing
Sheet 1/4--.

Express Mail Label No.: EL595431903US

REMARKS

If there are any additional fees resulting from this communication not covered by the enclosed check, or if the check was omitted, please charge all uncovered fees to our Deposit Account No. 16-0820, our Order No. 33220

Respectfully submitted,

PEARNE & GORDON LLP

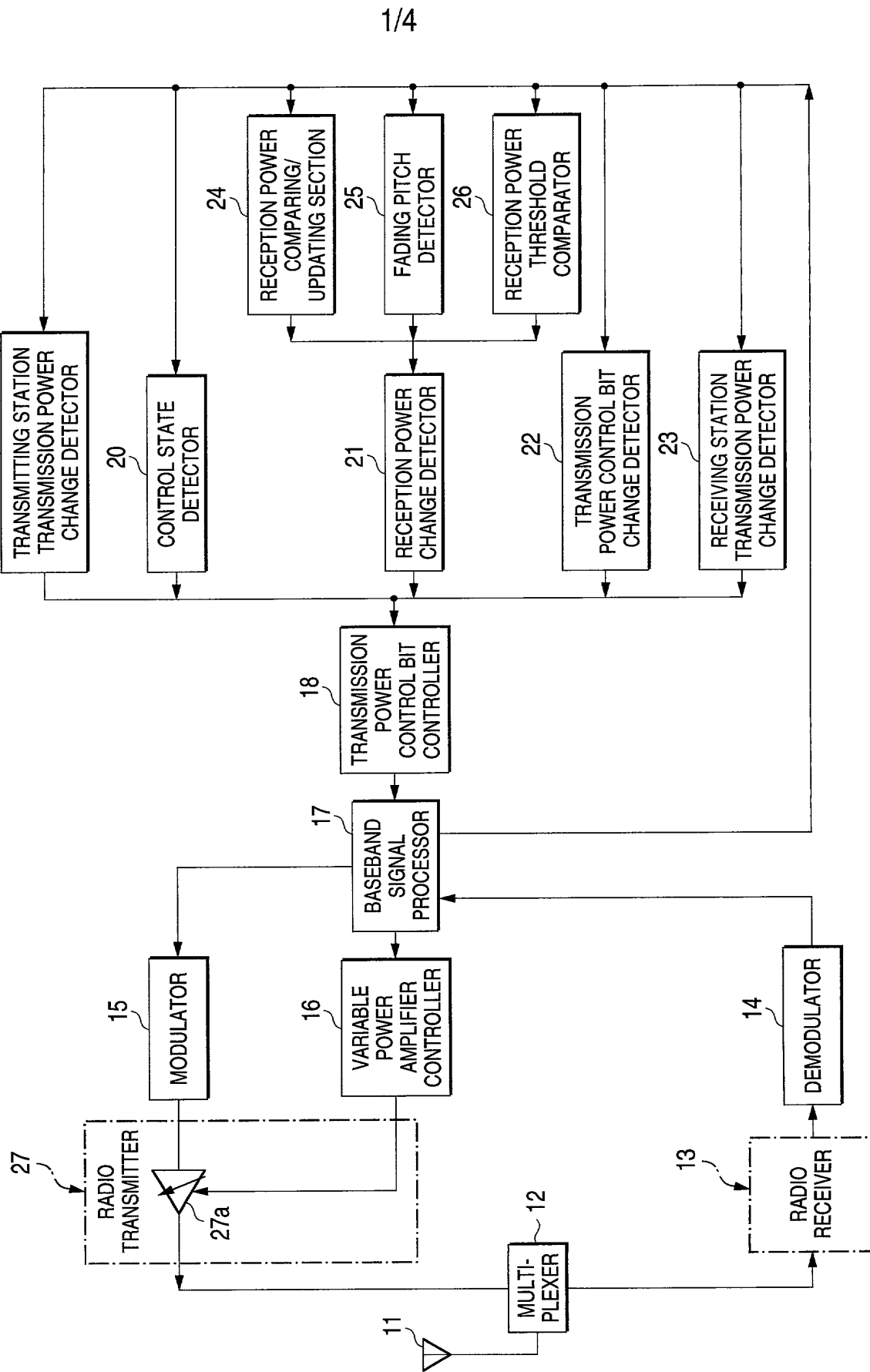
By


Michael W. Garvey, Reg. No. 35878

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Cleveland, Ohio 44114-1484
(216) 579-1700

January 31, 2001

FIG. 1



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DESCRIPTION

RADIO COMMUNICATIONS APPARATUS, METHOD FOR CONTROLLING
TRANSMISSION POWER OF RADIO COMMUNICATIONS APPARATUS AND
5 RECORDING MEDIUM TO WHICH THE METHOD BEING RECORDED

FIELD OF THE INVENTION

The present invention relates to a radio communications
apparatus used for a mobile communications system, etc. including
10 a portable telephone set, etc. which performs mobile
communications, a method for the radio communications apparatus
to control transmission power between a mobile station and a base
station, etc. in the mobile communications system, and a
computer-readable recording medium which stores the transmission
15 power control method.

BACKGROUND OF THE INVENTION

In a mobile communications system of the Code Division
Multiple Access (CDMA) using the spread spectrum technology, a
single frequency bandwidth is shared by a plurality of users. Thus
20 a so-called problem of strong-field channel/weak-field channel
may easily arise that a high-power signal masks a low-power signal,
resulting in degradation of the line quality of a local station
caused by a signal from another station appearing as an
interference wave. In such a mobile communications system, a

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transmission power control technology has been studied for reducing interference between communications channels to upgrade the frequency use efficiency, by controlling the transmission power of a local station depending on the distance between a base station and a mobile station in transmitting information and by holding constant the power of a signal arriving at the base station.

As a transmission power control system, in particular, there is known a transmission power control system via a closed loop to respond to an interference signal which instantaneously varies. Japanese patent publication H08-032513 discloses an example wherein transmission power control is made according to the control amount corresponding to a preset number of successive reception times when the same transmission power control bit is successively received in order to respond to a sudden variation in the reception power on a communication channel. The CDMA system requires, in particular, a wide-dynamic-range (for example 70 to 80dB), high-linearity transmission power control. The wide-band CDMA (W-CDMA) system requires a high accuracy of transmission power in high-power operation, thus a higher-accuracy transmission power control is required.

Fig. 4 is a flowchart of an example of a conventional transmission power control system via a closed loop. In case a base station and a mobile station communicate with each other, the base station determines a transmission power control bit based

on the reception power of a received wave or desired wave from the mobile station (S11), inserts the transmission power control bit in a transmission signal, and transmits this signal to the mobile station. The mobile station receives the signal from the base station, extracts the transmission power control bit from the received signal (S15) and controls the transmission power of the mobile station according to the instruction in the transmission power control bit (S16).

Similarly, the mobile station determines a transmission power control bit based on the reception power of a received wave or desired wave from the base station (S14), inserts the transmission power control bit in a transmission signal, and transmits this signal to the base station. The base station receives the signal from the mobile station, extracts the transmission power control bit from the received signal (S12) and controls the transmission power of the base station according to the instruction in the transmission power control bit (S13).

By performing such transmission power control, reception power at the base station and the mobile station can be held substantially constant, irrespective of the location of the mobile station.

In order to perform high-accuracy transmission power control by way of the aforementioned conventional transmission power control method, the transmission power control range

corresponding to the value of the transmission power control bit (one unit) must be made small. There is, however, a problem that a smaller transmission power control range cannot respond to a sudden variation in reception power, resulting in lower accuracy of transmission power control.

DISCLOSURE OF THE INVENTION

The invention solves such problems in the conventional technology. The invention aims at providing radio communications apparatus wherein accuracy of transmission power control can be upgraded by changing the transmission power control range depending on the communication state and thus low-power, compact-size apparatus can be provided, a transmission power controlling method for the radio communications apparatus, and a computer-readable recording medium which stores the transmission power control method.

To attain the aforementioned purpose, as mentioned in the first aspect of the invention, a radio communications apparatus according to the invention is a radio communications apparatus having a transmission power control feature for controlling the transmission power of a local station by using the transmission power control bit transmitted from a distant station to the local station, wherein the apparatus comprises: communication state detecting means for detecting the communication state based on the reception power of a received signal transmitted from the

distant station; and transmission power control range changing means for changing the transmission power control range corresponding to the transmission power control bit based on the detected communication state.

5 Preferably, as mentioned in the second through sixth aspect of the invention, the communication state detecting means has at least one of the following: reception power change detecting means for detecting a change in reception power in a local station; distant station transmission power change detecting means for
10 detecting a change in transmission power in a distant station; control state detecting means for detecting the control state of the local station; local station transmission power change detecting means for detecting a change in transmission power in the local station; and transmission power control bit change
15 detecting means for detecting a change in the transmission power control bit.

Preferably, as mentioned in the seventh through ninth aspect of the invention, the reception power change detecting means has at least one of the following: reception power comparing means
20 for comparing a previous reception power with a current reception power; fading pitch detecting means for detecting the fading pitch of reception power; and reception power threshold comparing means for comparing the reception power with a predetermined threshold.

As mentioned in the tenth aspect of the invention, a

transmission power control method according to the invention is a method for controlling transmission power of a local station by using a transmission power control bit transmitted from a distant station to the local station, wherein the method has: a
5 communication state detecting step for detecting the communication state based on the reception power of a received signal from the distant station; and transmission power control range changing step for changing the transmission power control range corresponding to the transmission power control bit based
10 on the detected communication state.

Preferably, as mentioned in the eleventh aspect of the invention, the communication state detecting step has a reception power change detecting step for detecting a change in reception power in a local station, and the transmission power control range
15 changing step changes the transmission power control range depending on the detected change in the reception power.

Alternatively, as mentioned in the twelfth aspect of the invention, the communication state detecting step has a distant station transmission power change detecting step for detecting
20 a change in transmission power in a distant station and a reception power change detecting step for detecting a change in reception power in a local station, and the transmission power control range changing step changes the transmission power control range depending on the detected change in transmission power in the

distant station and the detected change in reception power in the local station.

Alternatively, as mentioned in the thirteenth aspect of the invention, the communication state detecting step has a control
5 state detecting step for detecting the control state of a local station, and the transmission power control range changing step changes the transmission power control range depending on the detected control state.

Alternatively, as mentioned in the fourteenth aspect of the
10 invention, the communication state detecting step has a local station transmission power change detecting step for detecting a change in transmission power in a local station and a transmission power control bit change detecting step for detecting a change in the transmission power control bit, and the
15 transmission power control range changing step changes the transmission power control range depending on the detected change in transmission power in the local station and the detected change in the transmission power control bit.

Preferably, as mentioned in the fifteenth aspect of the
20 invention, the reception power change detecting step has a reception power comparing step for comparing a previous reception power with a current reception power, and a change in reception power is detected based on the comparison results of the reception power comparing step.

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Alternatively, as mentioned in the sixteenth aspect of the invention, the reception power change detecting step has a fading pitch detecting step for detecting the fading pitch of reception power, and a change in reception power is detected based on the
5 detected fading pitch.

Alternatively, as mentioned in the seventeenth aspect of the invention, the reception power change detecting step has a reception power comparing step for comparing a previous reception power with a current reception power and a fading pitch detecting
10 step for detecting the fading pitch of reception power, and a change in reception power is detected based on the comparison results of the reception power comparing step and the detected fading pitch.

Alternatively, as mentioned in the eighteenth aspect of the invention, the reception power change detecting step has a reception power threshold comparing step for comparing the
15 reception power with a predetermined threshold, and a change in reception power is detected based on the comparison results of the reception power threshold comparing step

As mentioned in the nineteenth aspect of the invention, a
20 computer-readable recording medium according to the invention is stored as a program for executing the transmission power control method for the radio communications apparatus according to the tenth, eleventh, twelfth, thirteenth, fourteenth, fifteenth,

sixteenth, seventeenth or eighteenth aspect of the invention.

According to the invention, when transmission power of a local station is controlled by using the transmission power control bit transmitted from a distant station to the local station, the communication state is detected based on the reception power of a signal transmitted from the distant station and the transmission power control range corresponding to the transmission power control bit is changed based on the detected communication state. The transmission power control range is controlled based on at least one of a change in reception power in the local station, a change in transmission power in a distant station, the control state of the local station, a change in transmission power in the local station, and a change in the transmission power control bit.

When a change in reception power is detected, the change in reception power is detected based on at least one of the comparison results of stored previous (previously controlled) reception power and current (currently controlled) reception power, a fading pitch of reception power, and the comparison results of reception power and a predetermined threshold. When a change in transmission power in a local station or a distant station is detected, the change in transmission power in a local station or a distant station is detected based on the comparison results of stored previous transmission power and current transmission power.

When a change in the transmission power control bit is detected, the change in the transmission power control bit is detected based on the comparison results of a stored previous transmission power control bit and the current transmission power control bit.

5 The invention thus allows response to a sudden change in reception power, control of response to predetermined power in a short period and suppression of interference waves, reducing errors in transmission power control in any communication state.

10 This upgrades accuracy of transmission power control. The upgrading of accuracy of transmission power control can minimize the required transmission power and realizes low-power, compact-size apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

15 Fig. 1 is a block diagram showing a configuration of the main section of radio communications apparatus according to one embodiment of the invention.

 Fig. 2 is a flow chart showing the procedure for the transmission power control method according to one embodiment of the invention.

20 Fig. 3 is a flow chart showing the procedure for the transmission power control method according to one embodiment of the invention.

 Fig. 4 is a flow chart showing an example of the procedure for the transmission power control method via a conventional

closed loop.

PREFERRED EMBODIMENTS OF THE INVENTION

Embodiments according to the invention will be detailed with reference to the drawings.

5 Fig. 1 is a block diagram of the main section of radio communications apparatus according to one embodiment of the invention. Figs. 2 and 3 are flowcharts showing the transmission power control method according to one embodiment of the invention.

10 Radio communications apparatus according to this embodiment is provided, for example, in a mobile communications device composing a base station or a mobile station of a cellular communications system, and amplifies the power of a signal containing transmission information to transmit the resulting signal to a distant party. A transmission power control method
15 described herein is preferable in a case where high-accuracy transmission power control is required while high linearity is being maintained, such as, in particular, a base station and a mobile terminal such as a mobile telephone set in a CDMA mobile communication system. This embodiment is not limited to a mobile
20 communications device but applicable to other radio communications apparatus which requires similar transmission power control as required.

This example shows only a configuration associated with transmission power control of radio communications apparatus.

Any configuration associated with other processing such as circuits and input keys associated with diffusion, inverse diffusion, encoding, decoding, speech transmitting, speech receiving, and control is not shown.

5 Radio communications apparatus has an antenna 11 for transmitting/receiving radio signals and a multiplexer 12 for isolating a transmission signal from a received signal. The radio communications apparatus has, as a receiving system: a radio receiver 13 comprising a high-frequency amplifier circuit, a
10 local oscillator circuit, and an IF signal amplifier circuit, etc. for high-frequency amplifying the received signal and outputting an intermediate frequency (IF) signal converted to an IF band (intermediate frequency band); a demodulator 14 for converting a received signal to a baseband signal; and a baseband signal
15 processor 17 for processing and decoding a received baseband signal.

 The radio communications apparatus has, as a transmission system: the baseband signal processor 17 for processing and encoding a baseband signal to be transmitted; a modulator 15 for
20 modulating a transmission signal to an IF signal; and a radio transmitter 27 for amplifying power of a transmission signal and frequency-converting the transmission signal to an RF band (radio frequency band). The radio transmitter 27 is equipped with a variable power amplifier 27a. The radio transmitter 27 is also

equipped with a frequency converter circuit for conversion to an RF band and a transmitter amplifier for output power amplification and so on, which are not shown.

The radio communications apparatus has, as a transmission
5 power control system, the baseband signal processor 17 and the
variable power amplifier 27a. The radio communications
apparatus has: a variable power amplifier controller 16 for
performing amplifier gain control of the variable power amplifier
27a to execute transmission power control; and a transmission
10 power control bit controller 18 as transmission power control
range change means for changing the transmission power control
range of a transmission power control bit, based on each of the
output results from a transmitting station transmission power
change detector 19 mentioned later through a receiving station
15 transmission power change detector 23.

The radio communications apparatus has, as a component
corresponding to communication state detecting means for
generating an input signal to the transmission power control bit
controller 18; a transmitting station transmission power change
20 detector 19 as local station transmission power change detecting
means for detecting a change in a transmitting station or a local
station, based on an output signal from the baseband signal
processor 17; a control state detector 20 as control state
detecting means for detecting the control state of a local

station; a reception power change detector 21 as reception power change detecting means for detecting a change in reception power in a local station; a transmission power control bit change detector 22 as transmission power control bit change detecting means for detecting a change in the transmission power control bit; and a receiving station transmission power change detector 23 as distant station transmission power change means for detecting a change in transmission power in a receiving station or a distant station.

Moreover, the radio communications apparatus has, as a component for generating an input signal to the reception power change detector 21: a reception power comparing/updating section 24 as reception power comparing means for comparing reception power in a local station with a stored previous power value and updating the stored power value; a fading pitch detector 25 as fading pitch detecting means for detecting the level variation cycle of a received signal which accompanies fading in the local station; and a reception power threshold comparator 26 as reception power threshold comparing means for comparing reception power in a local station with a predetermined threshold.

In this embodiment, the transmission power control range corresponding to the value of the transmission power control bit (one unit) for power control to be appended to a transmitted signal is changed. This is to upgrade the transmission power control

accuracy by performing transmission power control based on the transmission power control range to reflect the communication state on the transmitting side and the receiving side which depends on such factors as a change in communications.

5 In case apparatus shown in Fig. 1 is a mobile station, the baseband signal processor 17 determines a transmission power control bit based on the reception power of a received wave (desired wave) from a base station, and inserts the transmission power control bit in a transmission signal. The end signal is
10 modulated and frequency-converted to an IF band by the modulator 15, frequency-converted to an RF band by a radio transmitter 27, then transmitted to the base station from the antenna 11 via the multiplexer 12.

 A signal transmitted from the base station is received by
15 the antenna 11. The received signal is input to the radio receiver 13 via the multiplexer 12. The received signal is frequency-converted to an IF band by the radio receiver 13, converted to a baseband signal by the demodulator 14, and input to the baseband signal processor 17 for necessary processing. Signals
20 representing the transmission power control bit and reception power level, etc. are then generated.

 The transmitting station transmission power change detector 19 detects a change in transmission power in a mobile station or a local station (transmitting station) based on an output signal

from the baseband signal processor 17. The control state detector 20 detects the control state of the local station based on an output signal from the baseband signal processor 17. The transmission power control bit change detector 22 detects a change in the transmission power control bit based on an output signal from the baseband signal processor 17. The receiving station transmission power change detector 23 detects a change in transmission power in a base station or a distant station (receiving station) based on an output signal from the baseband signal processor 17.

Moreover, the reception power comparing/updating section 24 obtains a change in reception power in a mobile station by comparing reception power with stored previous power value and updates the stored power value based on an output signal from the baseband signal processor 17. The fading pitch detector 25 detects the level variation cycle of a received signal which accompanies fading in a mobile station based on an output signal from the baseband signal processor 17. The reception power threshold comparator 26 obtains a change in reception power relative to a predetermined threshold in a mobile station by comparing reception power with the predetermined threshold based on an output signal from the baseband signal processor 17. The reception power change detector 21 detects a change in reception power from each of the output results of the reception power

comparing/updating section 24, fading pitch detector 25, and reception power threshold comparator 26.

Although the fading pitch detector 25 is generally provided in a mobile communications device such as a cellular portable telephone set, it can be of any configuration provided the level variation cycle of a received signal which accompanies fading can be detected. Detection of the fading can be used to determine the traveling speed of a mobile station for proper control of reception a signal from the base station of an adjacent cell in the case of a handover.

The transmission power control bit controller 18 changes the transmission power control range of the transmission power control bit, based on each of the output results from the transmitting station transmission power change detector 19 through the receiving station transmission power change detector 23 and inputs the resulting signal to the power amplifier controller 16 via the baseband signal processor 17. The variable power amplifier controller 16 controls transmission power to be output from the antenna 11 by performing amplifier gain control of the variable power amplifier 27a based on the transmission power control bit and the changed transmission power control range.

Next, the procedure for the transmission power control method according to the invention will be detailed based on Fig.

2 and Fig. 3.

In this embodiment, the communication state of each of the receiving station and the transmitting station is detected based on the information (1) through (5) below. The transmission power control range corresponding to the transmission power control bit is changed according to the communication state.

- (1) Change in reception power in the receiving station
- (2) Change in transmission power in the transmitting station
- (3) Control state in the reception station
- 10 (4) Change in transmission power in the receiving station
- (5) Change in the transmission power control bit

- (1) Change in reception power in the receiving station is obtained based on detection results of (a) through (c) below.
 - (a) Change of the current reception power relative to the reception power under the previous control
 - 15 (b) Fading pitch
 - (c) Difference of the current reception power relative to the predetermined threshold

At least one of the elements (1) through (5) can be arbitrarily combined with at least one of the elements (a) through (c) and used in the procedure for changing the transmission power control range of the transmission power control bit.

Referring to Fig. 2 and Fig. 3, in case a base station and a mobile station communicate with each other, the base station

determines a transmission power control bit based on the reception power of a received wave or desired wave from the mobile station (S101), changes the transmission power control range corresponding to the transmission power control bit (S112),
5 inserts the transmission power control bit in a transmission signal, and transmits this signal to the mobile station. The mobile station receives the signal from the base station, extracts the transmission power control bit from the received signal (S206) and controls the transmission power of the mobile station
10 according to the instruction in the transmission power control bit (S213).

Next, the mobile station compares reception power stored by the mobile station with the current reception power (S205). The mobile station changes the reception power stored by the mobile
15 station to the current value (S207), detects a change in reception power based on the comparison results (S210), and changes the transmission power control range corresponding to the transmission power control bit (S212).

In the processing of step S210, the ratio of change in
20 reception power in the mobile station is detected from the magnitude of the absolute value of comparison results. Thus, the greater the ratio of change in reception power, the more accurate response to a sudden change in reception power is realized by extending the transmission power control range of the

transmission power control bit in the processing of step S212, unlike a conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy.

5 Next, the mobile station detects the fading pitch of reception power (S204) and detects a change in reception power based on the detection results of the fading pitch (S210). The mobile station then changes the transmission power control range corresponding to the transmission power control bit depending on
10 the detected change in reception power (S212).

In the processing of step S210, the speed of change in reception power in the mobile station is detected from the fading pitch. Thus, same as the foregoing case, the greater the speed of change in reception power, the more accurate response to a
15 sudden change in reception power is realized by extending the transmission power control range of the transmission power control bit in the processing of step S212, compared with a conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy.

20 In the processing of step S210, the speed of change and the ratio of change in reception power in the mobile station are detected from the fading pitch detected in step S204 and the magnitude of the absolute value of reception power comparison results detected in step S205. Thus the traveling status of a

local station can be assumed from the speed of change and the ratio of change in reception power detected. For example, in case the speed of change is reception power is low and the ratio of change in reception power is large, it can be assumed that the local station is traveling at a low speed in an area where the local station is in the shadow of buildings, etc. in terms of radio waves.

Here, in case reception power decreases, the mobile station is assumed to be traveling into an area where incoming radio waves are weakened by buildings. By reducing the transmission power control range corresponding to the transmission power control bit in the processing of step S212, a sudden increase in transmission power of the base station can be suppressed. As a result, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy. Meanwhile, in case reception power increases, the mobile station is assumed to be traveling out of an area where incoming radio waves are weakened by buildings. By extending the transmission power control range corresponding to the transmission power control bit in the processing of step S212, a sudden decrease in the transmission power of the base station can be realized. As a result, same as the foregoing case, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike

the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy.

Next, the mobile station compares reception power with a predetermined threshold (S203). The mobile station detects a
5 change in reception power based on the comparison results (S210) and changes the transmission power control range corresponding to the transmission power control bit (S212).

In the processing of step S210, the mobile station can assume its location based on the comparison results of reception power
10 detected in step S203 and the ratio of the desired wave received signal power to the interference wave power (SIR: Signal-to-Interference Power Ratio). For example, in case reception power is smaller than the predetermined threshold and SIR is small, the mobile station is assumed to be in a weak electric field (area
15 with weak receiving field intensity) such as an area shadowed by buildings. On the other hand, in case reception power is greater than the predetermined threshold SIR is small, the mobile station is assumed to be in a strong electric field (area with strong receiving field intensity and an interference).

20 Thus, in case the local station is in a weak electric field, a sudden increase in transmission power of the base station can be suppressed by reducing the transmission power control range of the transmission power control bit in the processing of step S212 and initiating the handover of an ongoing call to another

base station. As a result, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy. In case the local station is affected by a strong field interference, a sudden increase in transmission power of the base station can be suppressed by reducing the transmission power control range of the transmission power control bit in the processing of step S212. As a result, same as the foregoing case, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy.

Next, the mobile station detects the local control state (S202) and changes the transmission power control range corresponding to the transmission power control bit based on the detection results (S212). In the processing of step S202, the mobile station can detect the control state of the local station transmission power. Thus, in starting the transmission power control, response to predetermined power in a short period is realized by extending the transmission power control range corresponding to the transmission power control bit in the processing of step S212, unlike a conventional method using a fixed transmission power control range. This upgrades the

transmission power control accuracy.

Next, the mobile station compares distant station transmission power under the previous control stored by the mobile station with distant station transmission power under the current control (S214). The mobile station updates the value of distant station transmission power under the previous control to the current value (S215), and detects a change in transmission power of the base station based on the comparison results (S216). The mobile station changes the transmission power control range of the transmission power control bit based on the detected change in the transmission power of the base station and the change in reception power detected in step S210 (S212).

In the processing of step S212, the mobile station can assume its traveling status based on the change in the transmission power of the base station and the change in the local station reception power. For example, in case transmission power of the base station increases and local station reception power decreases, the mobile station is assumed to be traveling into a weak electric field such as an area shadowed by buildings. On the other hand, in case transmission power of the base station decreases and the local station reception power increases, the mobile station is assumed to be traveling into a strong electric field such as an area out of a shadow of buildings.

Thus, in case the local station is traveling into a weak

electric field, a sudden increase in transmission power of the base station can be suppressed by reducing the transmission power control range corresponding to the transmission power control bit in the processing of step S212 and initiating the handover of an ongoing call to another base station. As a result, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy. In case the local station is traveling into a strong field, a sudden decrease in transmission power of the base station can be realized by extending the transmission power control range corresponding to the transmission power control bit in the processing of step S212.

As a result, same as the foregoing case, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy.

Next, the mobile station updates the distant station transmission power to the distant station under the current control based on the transmission power control bit determined in step S201 (S217). The mobile station updates the local station transmission power based on the transmission power control bit extracted in step S206 (S218). Next, the mobile station compares

local station transmission power under the previous control stored by the mobile station with local station transmission power under the current control (S219), updates the stored local station transmission power under the previous control to the current value
5 (S220), and detects a change in transmission power of the local station based on the comparison results (S221).

Next, the mobile station compares transmission power control bit stored by the mobile station with the current transmission power control bit (S208), updates the stored transmission power
10 control bit (S209), and detects a change in the transmission power control bit based on the comparison results (S211).

Next, the mobile station changes the transmission power control range corresponding to the transmission power control bit based on the change in transmission power of the local station
15 detected in step S221 and the change in the transmission power control bit detected in step S211 (S212).

In the processing of step S212, the mobile station can assume its location based on the change in the transmission power of the mobile station and the change in the transmission power control
20 bit. For example, in case transmission power of the mobile station increases and the transmission power control bit increases, the mobile station is assumed to be in a weak electric field such as an area shadowed by buildings. On the other hand, in case transmission power of the mobile station decreases and

the transmission power control bit decreases, the mobile station is assumed to be in a strong electric field.

Thus, in case the local station is in a weak electric field, a sudden increase in transmission power of the base station can be suppressed by reducing the transmission power control range corresponding the transmission power control bit in the processing of step S212 and initiating the handover of an ongoing call to another base station. As a result, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy. In case the local station is traveling into a strong field, a sudden decrease in transmission power of the base station can be realized by extending the transmission power control range of the transmission power control bit in the processing of step S212.

As a result, interference by a wave transmitted from the base station to another mobile station can be suppressed, unlike the conventional method using a fixed transmission power control range. This upgrades the transmission power control accuracy.

By changing the transmission power control range via the aforementioned processing, response to a sudden change in reception power, response to a desired power in a short period and suppression of interference waves are made possible and errors

in transmission power control can be reduced in any communication state. This upgrades accuracy of transmission power control.

Next, the mobile station determines the transmission power control bit based on the reception power of a received wave or desired wave from the base station (S201), inserts the transmission power control bit instructing the transmission power control range changed in step S212 in a transmission signal, and transmits this signal to the base station. The base station receives the signal from the mobile station, extracts the transmission power control bit from the received signal (S106) and controls the transmission power of the base station according to the instruction in the transmission power control bit (S113).

Processing of step S102 through S121 is the same as the aforementioned step S202 through S221 for a mobile station.

The processing allows, same as the aforementioned mobile station, response to a sudden change in reception power, response to a desired power in a short period and suppression of interference waves are made possible and errors in transmission power control can be reduced in any communication state. This upgrades accuracy of transmission power control.

As mentioned earlier, this embodiment allows easy response to a sudden change in reception power, etc. while high-accuracy transmission power control is being made, by changing the transmission power control range corresponding to the

transmission power control bit depending on the communication state, thus ensuring a high-accuracy transmission power control in any communication state. This upgrades the overall accuracy of transmission power control. The upgrading of accuracy of transmission power control in a base station and a mobile station can minimize the required transmission power and realizes low-power, compact-size apparatus.

INDUSTRIAL APPLICABILITY

As mentioned above, according to the invention, when transmission power of a local station is controlled by using the transmission power control bit transmitted from a distant station to the local station, the communication state is detected based on the reception power of a signal transmitted from the distant station. By changing the transmission power control range corresponding to the transmission power control bit based on the detected communication state, to be more precise, at least one of a change in reception power in the local station, a change in transmission power in a distant station, the control state of the local station, a change in transmission power in the local station, and a change in the transmission power control bit, the accuracy of transmission power control can be upgraded. This also can realize low-power, compact-size apparatus.

CLAIMS

1. Radio communications apparatus having a transmission power control feature for controlling the transmission power of a local station by using the transmission power control bit
5 transmitted from a distant station to the local station, comprising:

communication state detector which detects the communication state based on the reception power of a received signal transmitted from the distant station; and

10 transmission power control range changer which changes the transmission power control range corresponding to the transmission power control bit based on the detected communication state.

2. The radio communications apparatus according to claim
15 1, wherein said communication state detector has a reception power change detector which detects a change in reception power in a local station.

3. The radio communications apparatus according to claim
20 transmission power change detector which detects a change in transmission power in a distant station.

4. The radio communications apparatus according to claim
1, wherein said communication state detector has a control state detector which detects the control state of the local station.

5. The radio communications apparatus according to claim 1, wherein said communication state detector has a local station transmission power change detector which detects a change in transmission power in the local station.

5 6. The radio communications apparatus according to claim 1, wherein said communication state detector has a transmission power control bit change detector which detects a change in said transmission power control bit.

10 7. The radio communications apparatus according to claim 2, wherein said reception power change detector has a reception power comparator which compares a previous reception power with a current reception power.

15 8. The radio communications apparatus according to claim 2, wherein said reception power change detector has a fading pitch detector which detects the fading pitch of reception power

9. The radio communications apparatus according to claim 2, wherein said reception power change detector has a reception power threshold comparator which compares the reception power with a predetermined threshold.

20 10. A transmission power control method for radio communications apparatus for controlling transmission power of a local station by using a transmission power control bit transmitted from a distant station to the local station, comprising:

a communication state detecting step which detects the communication state based on the reception power of a received signal transmitted from the distant station; and

transmission power control range changing step which changes
5 the transmission power control range corresponding to the transmission power control bit based on the detected communication state.

11. The transmission power control method for radio communications apparatus according to claim 10,

10 wherein said communication state detecting step has a reception power change detecting step which detects a change in reception power in a local station,

wherein said transmission power control range changing step changes the transmission power control range depending on the
15 detected change in reception power.

12. The transmission power control method for radio communications apparatus according to claim 10,

wherein said communication state detecting step has a distant station transmission power change detecting step which
20 detects a change in transmission power in a distant station and a reception power change detecting step which detects a change in reception power in a local station,

wherein said transmission power control range changing step changes the transmission power control range depending on the

reception power comparing step which compares a previous reception power with a current reception power,

wherein a change in reception power is detected based on the comparison results of the reception power comparing step.

5 16. The transmission power control method for radio communications apparatus according to claim 11 or 12,

wherein said reception power change detecting step has a fading pitch detecting step which detects the fading pitch of reception power,

10 wherein a change in reception power is detected based on the detected fading pitch.

17. The transmission power control method for radio communications apparatus according to claim 11 or 12,

15 wherein said reception power change detecting step has a reception power comparing step which compares a previous reception power with a current reception power and a fading pitch detecting step for detecting the fading pitch of reception power,

20 wherein a change in reception power is detected based on the comparison results of the reception power comparing step and the detected fading pitch.

18. A transmission power control method for radio communications apparatus according to claim 11 or 12,

wherein said reception power change detecting step has a reception power threshold comparing step for compares the

reception power with a predetermined threshold,

wherein a change in reception power is detected based on the comparison results of the reception power threshold comparing step

- 5 19. A computer-readable recording medium stored as a program for executing the transmission power control method for the radio communications apparatus according to any one of claims 10 through 18.

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ABSTRACT

In controlling transmission power of a local station by using a transmission power control bit transmitted from a distant station (receiving station) to the local station (transmitting station), a communication state is detected by using at least one of a transmitting station transmission power change detector (19), a control state detector (20), reception power change detector (21), a transmission power control bit change detector (22), and a receiving station transmission power change detector (23), based on an output from a baseband signal processor (17). The transmission power control range corresponding to the transmission power control bit is changed based on the detection results of the detectors by a transmission power control bit controller (18). A variable power amplifier controller (16) controls a variable amplifier (27a) based on the transmission power control bit and the transmission power control range and variably controls the transmission power via an antenna (11).

FIG. 1

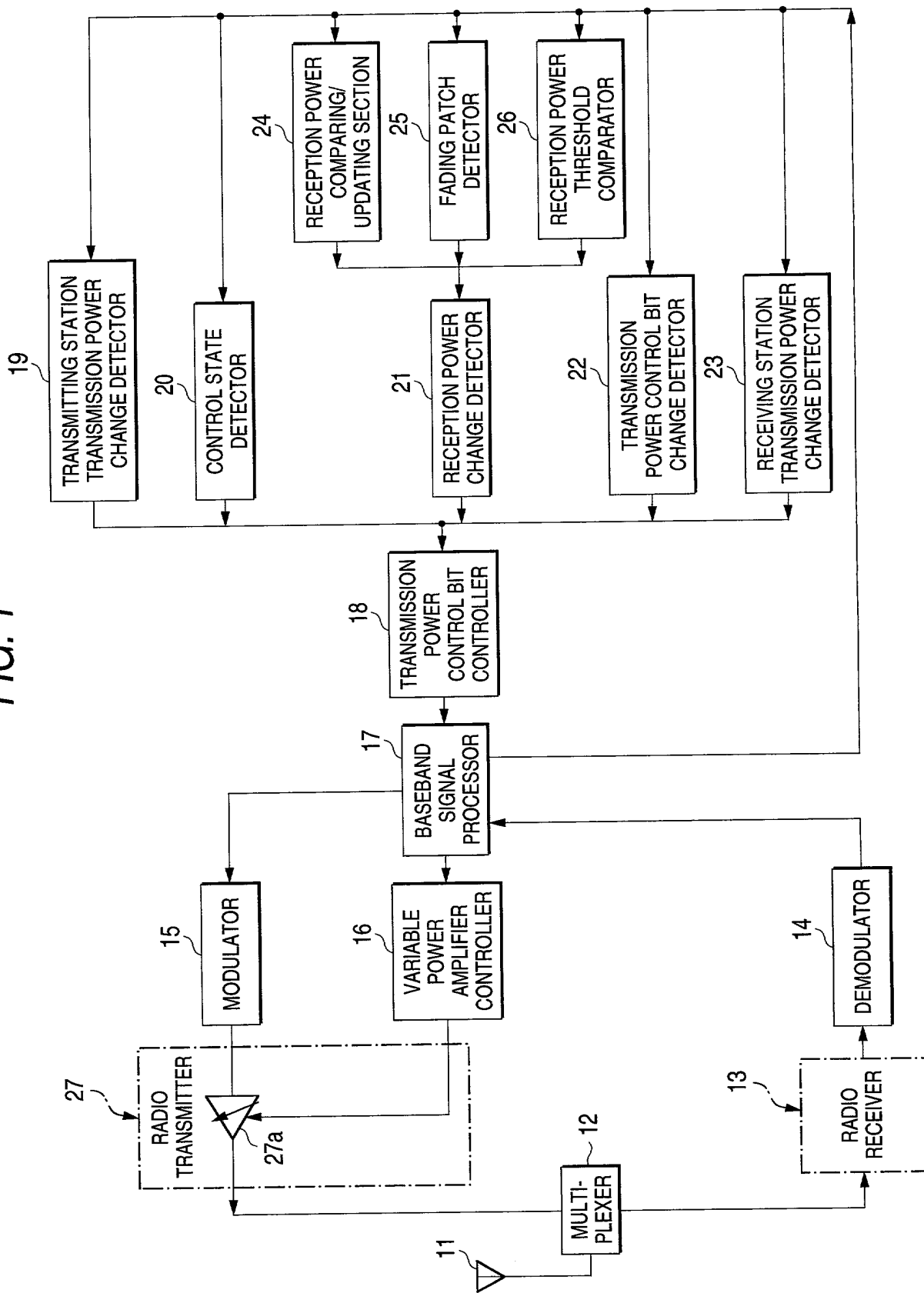
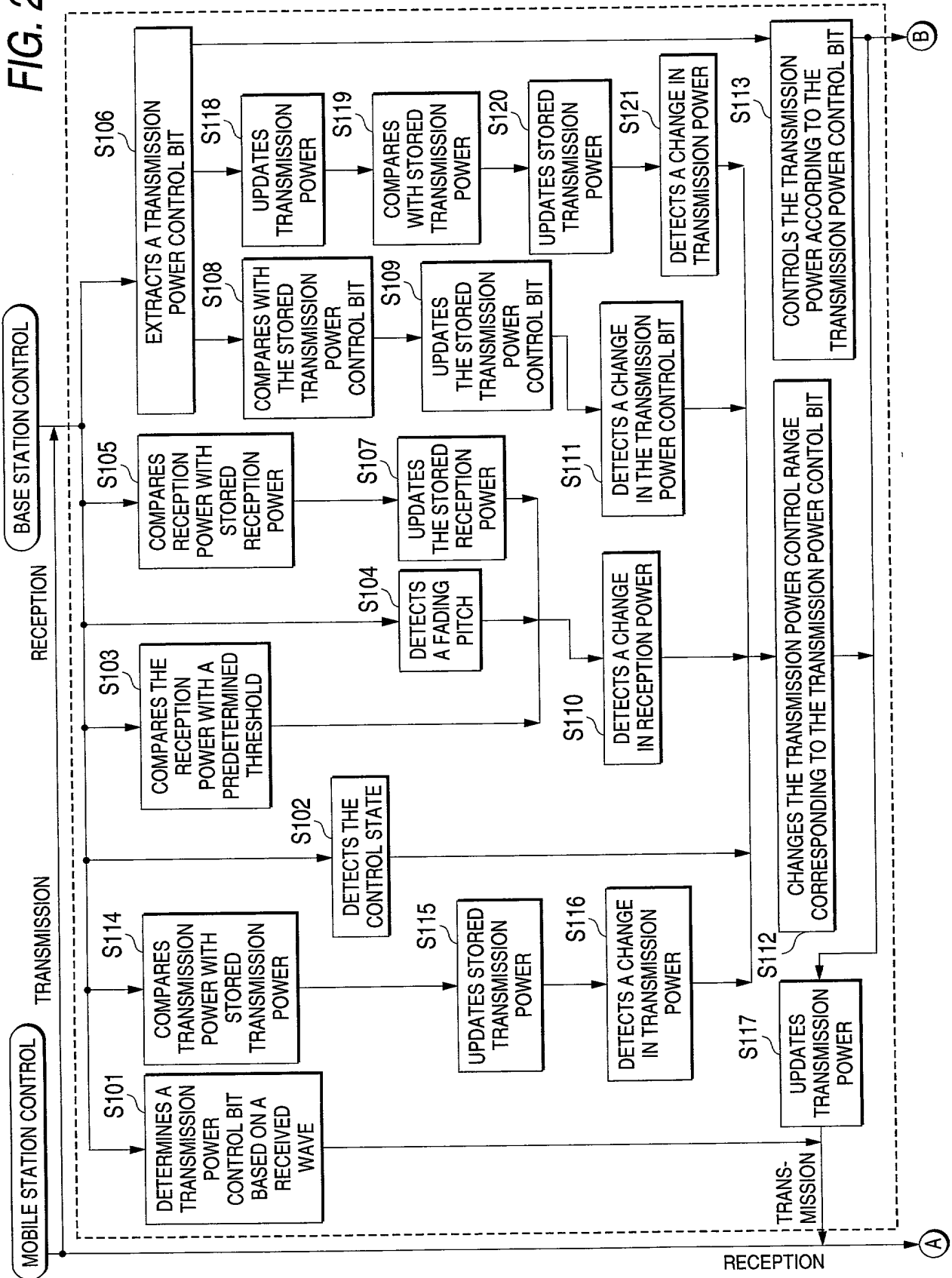
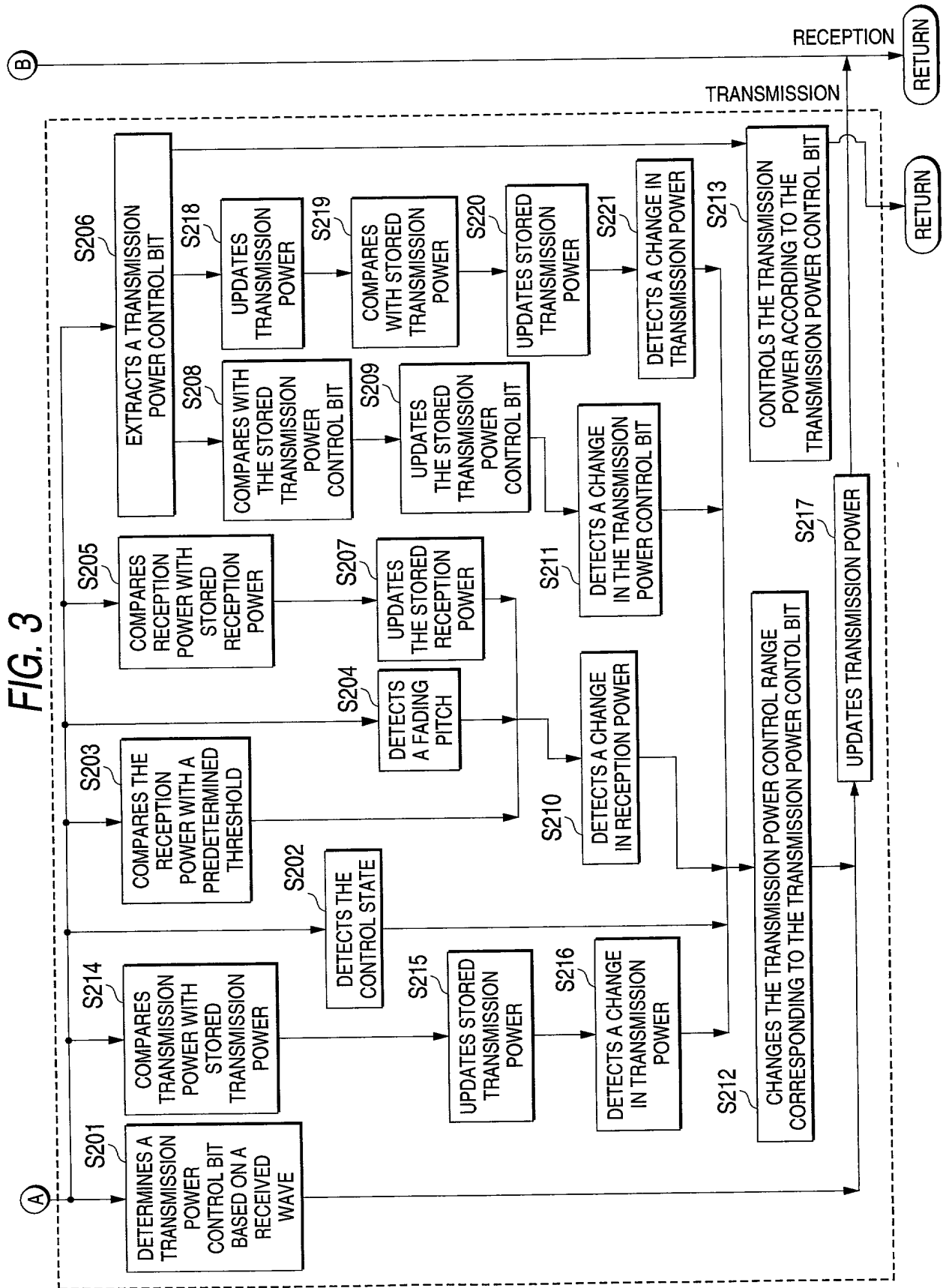
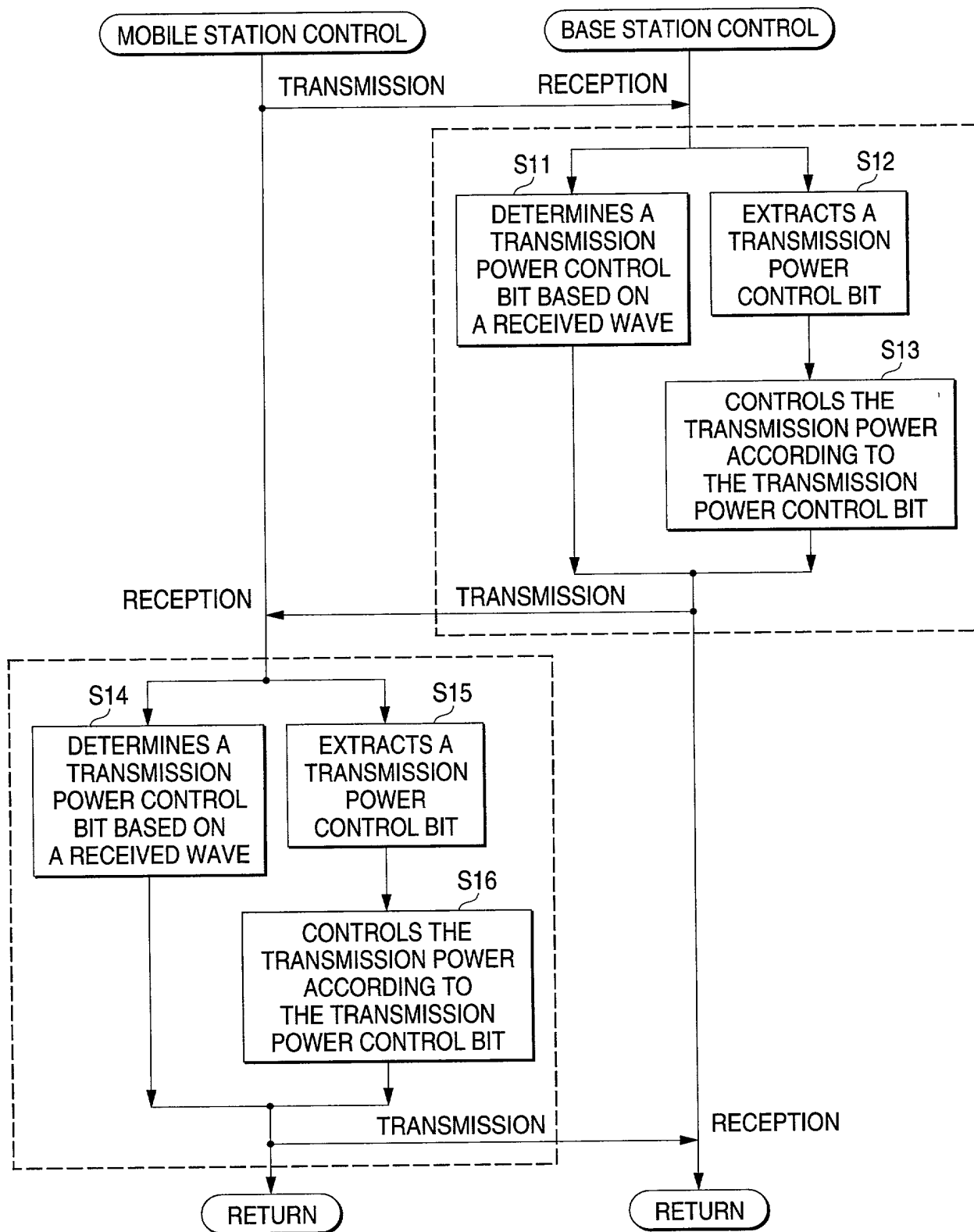


FIG. 2





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	First Named Inventor	Yasufumi Ichidawa
	COMPLETE IF KNOWN	
	Application Number	
	Filing Date	
	Group Art Unit	
	Examiner Name	

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As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**RADIO COMMUNICATIONS APPARATUS, METHOD FOR CONTROLLING
TRANSMISSION POWER OF RADIO COMMUNICATIONS APPARATUS AND
RECORDING MEDIUM TO WHICH THE METHOD BEING RECORDED**

(Title of the Invention)

the specification of which

☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY)

June/1/2000

as United States Application Number or PCT International

Application Number **PCT/JP00/03568** and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations, §1.56.

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Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
Pat. Hei. 11-156770	Japan	June 3, 1999	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
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Richard H. Dickinson, Jr.	18622	John P. Murtaugh	34226
Thomas P. Schiller	20677	James M. Moore	32923
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Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name	Yasufumi	Middle Initial		Family Name	ICHIKAWA	Suffix e.g. Jr.	
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Additional provisional applications:					
Application Number		Filing Date (MM/DD/YYYY)			
Additional U.S. applications:					
U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)		

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